DOCUMENT RESUME

ED 091 190 SE 017 740

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| TITLE | Information Memory Processing and Retrieval: Relationships of Learning and Cognition in a Verbal and Visual Task. |
| PUB DATE | 17 Apr 74 |
| NOTE | 33p.; Paper presented at the annual meeting of the National Association for Research in Science Teaching (47th, Chicago, Illinois, April 1974). For related documents, see SE 017 741 - 744 and SE 017 760 |
| EDRS PRICE | MF-$0.75 HC-$1.85 PLUS POSTAGE |
| DESCRIPTORS | *Cognitive Development; Cognitive Measurement; *Educational Research; Elementary School Students; *Information Theory; Junior High School Students; Observation; Recall (Psychological); Science Education |
| IDENTIFIERS | Research Reports |

ABSTRACT

One of a series of investigations on the Project on an Information Memory Model, the purpose of this study was to determine the amount and kind of visual information processed and stored in the memory of children using different modalities of observation. Children, aged 5, 9 and 13 years, were randomly assigned to one of three treatment groups. Two of the treatment groups individually viewed silently (N=21 per age level) or vocally (N=21 per age level) a projected 35mm slide of a living room. The third group (N-45 per age level) viewed the picture display in groups of three and verbally exchanged enumerations of items. Five minutes were allowed for viewing the slide. The subjects then verbally recalled the viewing experience and their recollections were tape recorded. As the age of the subjects increased, the numbe of picture item messages and variety or number of different picture items verbalized in the enumeration phase of the experiment also increased. A message processor algorithm for forecasting cognitions of verbal and nonverbal modalities was used with a prediction error of less than two percent. An item dimension algorithm for forecasting cognitions was developed to measure the M unit structure of memory pathways. The finding was that chronological age was related to M units of variations of learning and recall tasks. (Author/PEB)

# INFORMATION MEMORY PROCESSING AND RETRIEVAL: RELATIONSHIPS OF LEARNING AND COGNITION IN A VERBAL AND VISUAL TASK

NATIONAL ASSOCIATION FOR RESEARCH
IN SCIENCE TEACHING



ANNUAL CONFERENCE:
17 APRIL, 1974
CHICAGO, ILLINOIS

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Introduction. The human interacts with the environment by receiving information through the sensory and nervous systems, and in that manner effects the environment and the structure of the memory. This is the only way a researcher can explain how the human learns, be it in a school or non-school situation. Unfortunately, the researcher can only generalize the definition of learning. There is no precise definition nor can learning and cognition be finitely related in explaining how the memory performs such tasks. Why is it that after almost a century of psychological research, we still have no reliable means to say the human learned this and will be able to recall a specific quantity, either immediately or even 15 minutes later? The reason is quite evident, the researchers have not quantified the quality of the information processed from the environment, through the brain, and into a cognition.

According to Sinsheimer(1) the one million optic fibers of man permits the receiving of 40 to 50 bits of information in a flash and they can be held for about a second. He also claims no more than 10 bits of information can be abstracted per second. Moser(2) claims this is an exaggeration, probably to a magnitude of five. In any case, the amount of information processed for visual input has not been completely described. Fazio and Moser(3) reported on verbal material visually processed in an abstract problem solving task. Hsia(4) incompletely described a visual processing task and Salomon and Snow(5) attempted to establish the information exchange of film viewers.

Much of the problem of describing information processed in visual input tasks has been due to a philosophical controversy concerning the content of the information. Leeuwenberg(6) has stratified the controversy as being one of humans processing logon and metron kinds of information. Moser has disputed the distinction and has proven that (2) the claim of the C. Shannon Theory of Mathematical Communication(7) describing only metron content is erroneous.

The problem then was to attempt to quantitatively describe the information flow of humans who viewed a picture and then later recalled that experience. It was hypothesized that the information flow is a function of age and modality of experiencing the environment situation. An additional research question was whether or not humans of different age process information differently for verbal and non-verbal, or visual cognitions.

Purpose of the Study. There has never been any study done of how humans process figural items with regard to the information utilized for cognitions. As humans can sensually treat the environment information such a study needed to account for information processed silently or verbally and individually or in groups of humans. This kind of research consideration then takes into account the looping of information through the visual and auditory pathways of the human nervous system. The contradiction factor of such an approach was dealt with by including an experiment to measure cognitions done visually, and with no verbal feedback.

Procedure. Eighty-seven students from each of the three age levels were randomly selected from comparable grade levels of a suburban school district in Western Pennsylvania. The ages of the children were five, nine and thirteen years. The subjects were randomly assigned to one of three treatment groups.

Two of the treatment groups of subjects were set to individually, silently (N=21 per age level) or vocally (N=21 per age level) enumerate items of a projected 35 mm slide of a designed livingroom. The third group viewed the picture display in groups (N=45 per age level) of three subjects who verbally exchanged enumerations of items. Five minutes were allowed for this phase of the experiment. The vocal output was tape-recorded for further treatment.

The second phase of the experiment was a vocal enumeration of items in immediate and delayed recall. Each individual was given five minutes for the recall of items. Subjects of the two individual, silent and vocal, practice groups and one of the subjects from each group enumeration set did immediate recall tasks. The remaining two subjects of each group enumeration set were randomly assigned to five and ten minute delayed recall treatments.

Each subject did a visual recall task immediately after the vocal recall task. The subject was given a line drawing of the room originally shown in the 35 mm slide. Twenty line drawings of room items were randomly selected and presented to the subject for placement on location of the outline of the room. The space location items were then scored for correct placement by a six area section limit of the picture outline.

The audio tapes of the practice enumeration and vocal recall phases of the experiment were transcribed for item enumerations of picture items. Over 2,500 synonym enumerations were obatined and these were computer analyzed to establish a cross index for 134 items displayed in the picture of the room. The sequence of output of items by each subject for the practice enumeration phase was placed in a matrix for obtaining 30 different information measures, representing the information flow in the enumeration activity. The same procedure was used for obtaining information flow of item recall.

The variables of the experiment phases were analyzed using linear regression. The t-test was used for determining significances of difference between variables for groups of subjects in the three kinds of tasks.

Results. The number of picture item messages and variety or number of different picture items verbalized in the enumeration phase of the experiment increased as the age of the subjects increased. These trends are shown in Table 1. The change was an almost doubling of the messages and variety output by subjects aged five to thirteen years. Quite logically, groups of three subjects verbalized more messages than done by individual subjects of any age. Quite interestingly, however, the variety or number of different picture items noted by groups or individual subjects was quite similar in frequency. In other words groups of enumerators practiced more redundancy for recognizing the different items in a picture than was done by non-interactive situations, as found for individuals enumerating picture items.

The trend of age differences for the recall of picture items was somewhat different than that found for practice enumeration tasks. There was an increase in the number of messages and variety of items recalled by age groups, but the marked change was greater between five year old subjects than found for older subjects doing an immediate recall task. As indicated in Table 1, there was not a marked change in the level of recall for delayed cognitions of variety output by the subjects. There was, however, a greater decrease in the redundancy or output of messages, as there was an increase in the age of the subjects.

A correlated t-test analysis of the messages and variety practiced and then recalled by each treatment group indicated that the recall output was significantly less than that done in the practice enumeration phase. This was found the case for each age level. In other words, the level of cognition was lower in the amount of item processing than done in the learning task.

TABLE 1

Messages and Variety of Vocal Practice and Recall of Picture Items

| Treatment Group | Messages: Practice $\bar{X}$ | Messages: Practice S.D. | Messages: Recall $\bar{X}$ | Messages: Recall S.D. | Variety: Practice $\bar{X}$ | Variety: Practice S.D. | Variety: Recall $\bar{X}$ | Variety: Recall S.D. |
|---|---|---|---|---|---|---|---|---|
| 1) Individual Vocal Practice: | | | | | | | | |
| 5 years old (N=21) | 47.0 | 28.8 | 20.8 | 15.8 | 26.6 | 11.9 | 12.0 | 7.2 |
| 9 years old (N=21) | 86.6 | 31.2 | 69.1 | 28.5 | 45.7 | 10.4 | 32.9 | 10.6 |
| 13 years old (N=21) | 87.5 | 26.5 | 64.0 | 24.3 | 51.1 | 12.4 | 35.3 | 9.5 |
| 2) Group Practice: | | | | | | | | |
| 5 years (N=45) | 72.7 | 20.4 | | | 31.9 | 7.7 | | |
| 9 years (N=45) | 113.2 | 37.4 | | | 46.7 | 10.9 | | |
| 13 years (N=45) | 135.9 | 29.3 | | | 54.6 | 10.0 | | |
| 3) Group Practice: Recall | | | | | | | | |
| Immediate: | | | | | | | | |
| 5 years (N=15) | | | 17.3 | 8.4 | | | 11.3 | 5.3 |
| 9 years (N=15) | | | 53.1 | 20.4 | | | 26.3 | 7.1 |
| 13 years (N=15) | | | 65.7 | 20.8 | | | 34.2 | 9.4 |
| 5 Minute Delay | | | | | | | | |
| 5 years (N=15) | | | 21.1 | 17.3 | | | 13.3 | 7.6 |
| 9 years (N=15) | | | 65.6 | 30.2 | | | 30.7 | 9.9 |
| 13 years (N=15) | | | 76.5 | 35.6 | | | 36.3 | 11.5 |
| 10 Minute Delay | | | | | | | | |
| 5 years (N=15) | | | 19.1 | 12.5 | | | 13.5 | 8.1 |
| 9 years (N=15) | | | 57.2 | 21.2 | | | 27.0 | 7.6 |
| 13 years (N=15) | | | 70.5 | 22.6 | | | 34.9 | 8.9 |
| 4) Silent Individual Practice: | | | | | | | | |
| 5 years (N=21) | | | 15.7 | 9.5 | | | 10.1 | 6.8 |
| 9 years (N=21) | | | 34.4 | 13.1 | | | 21.6 | 7.2 |
| 13 years (N=21) | | | 52.6 | 20.6 | | | 30.1 | 8.4 |

The non-verbal spatial location of cut-outs of picture items was studied for age and modality differences. The average scores, for a maximum of 20 items, are shown in Table 2. The age groups were again found to differ in items located. The number of visual locations increased as age increased, with almost twice as many located by 13 year old subjects than done by five year old subjects. A t-test analysis shown in Figure I of the Appendix, showed this trend to be significant for ages, but not for practice enumeration modality. A major finding was that the transformation from verbal learning to recall to non-verbal, visual recall does not appreciably differ in terms of the manner by which subjects practice enumerate the learning task.

The NOISE:X information measure has been found in previous studies[3,8] to indicate the approach used by humans in strategy processing of a task. The average levels of NOISE:X for the ages and treatment groups are shown in Table 3. These levels show that the practice learning task was approached (see Figure 2 of the Appendix for t-test results) quite commonly, with the exception of five year old individuals. That age group had significantly lower levels of NOISE:X than found for subjects aged 9 or 13 years. The same trend existed for levels of NOISE:X processed by five year old individuals and groups of same age subjects who did the picture enumeration task. However, the NOISE:X level for the verbal item recall of individual five year old subjects was not significantly different for individuals of older ages. In addition, the five year old individuals who verbally recalled picture items and did the learning in groups of three also had significant changes in levels of NOISE:X for five and ten minute delayed recall tasks.

The general finding was that subjects of different ages did not appreciably differ in the strategy approach for either a learning task or a recall task involving the cognitive processing of visual picture items. The finding confirms those by Moser[2] and Fazio and Moser[3] that the task involved a strategy of low memory recall. The sample of input spurious information was between 8 and 23 percent or just above that of perceptional recognition strategies. As important is the finding that this kind of cognitive task shows little change for learning and cognition kinds of memory information processing.

The 9 and 13 year old treatment groups differed in levels of NOISE:X for all age levels with respect to the practice learning task done by individuals and groups of subjects. The same difference occurred between individuals of 9 and 13 years who silently enumerated but verbally recalled items, and were of a group in the learning task but individually conducted an immediate recall.

Eight other information measures were analyzed for significant differences of amounts and rates of information processed in verbal learning and recall tasks for figural information. The average amounts and rates of these measures

TABLE 2

Number of Picture Items Recalled and Visually Located on a Room Cutout

| Treatment Group | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| 1) Individual Vocal Practice: | 6.9 | 2.5 | 10.3 | 2.5 | 12.6 | 2.9 |
| 2) Group Practice: Recall | | | | | | |
| Immediate | 6.6 | 3.2 | 9.6 | 2.5 | 12.9 | 2.6 |
| 5 Minute Delay | 6.2 | 2.2 | 9.9 | 4.9 | 12.0 | 2.1 |
| 10 Minute Delay | 6.8 | 3.6 | 9.3 | 2.0 | 12.2 | 1.9 |
| 3) Silent Vocal Practice: | 6.8 | 2.4 | 8.4 | 3.1 | 12.7 | 2.5 |

TABLE 3

Rate of Input Channel Noise (X) for Vocal Practice and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 9.74[a] | 9.62 | 16.02 | 6.27 | 14.91 | 5.59 |
| Recall | 15.59 | 14.31 | 17.47 | 4.65 | 15.27 | 5.21 |
| 2) Group Practice: | | | | | | |
| Practice | 21.23 | 4.89 | 19.53 | 3.99 | 19.30 | 3.19 |
| Recall: Immediate | 15.74 | 13.37 | 18.48 | 6.51 | 19.34 | 5.96 |
| 5 Minute Delay | 12.94 | 10.71 | 17.73 | 5.42 | 17.77 | 5.73 |
| 10 Minute Delay | 7.94 | 8.25 | 18.81 | 5.92 | 13.57 | 4.74 |
| 3) Individual Silent: | | | | | | |
| Recall | 22.64 | 30.36 | 13.26 | 7.96 | 15.65 | 5.31 |

[a]To be read that 9.74% of the X message information was spurious.

per message transaction are shown in tables four through twelve. A t-test analysis comparison of significances of differences is listed in Figure 2 in the Appendix.

The amount of information encoded (CODE), see Table 4, by subjects was found to be significantly different for the practice learning task of subjects aged 9 and 13 years who had either been individual enumerators or members of a group of enumerators. The five year old subjects differed for group practice treatments with respect to the amount of information encoded in verbal recall in ten minute delay tasks.

The rate of information encoded (% CODE) in learning tasks (Table 5) by any age group differed for those of individuals, and groups of subjects. The same information measure was found to differ in the verbal recall of subjects aged 9 or 13 years who had either individually done the enumeration task or in groups of three subjects.

Several information rates and amounts were found to differ between groups of 5 and 13 year old subjects and individuals doing the learning tasks. The measures were % REAL:$M^1$ (Table 6), LTM:$M^1$ (Table 8), % LTM:$M^1$ (Table 9), REAL:SS (Table 10), and % REAL:SS (Table 11). The only exception was for the % LTM:$M^1$ processed by the five year old subjects. With the exception of % REAL:$M^1$, the rate or amount of information processed was greater for the recall task than for the learning task. The opposite effect existed for the rate of useful information (% REAL:$M^1$) shared by successive messages output under an original matrix condition.

The only significant difference between information flow in immediate and delayed recall was that of the five year old children. They processed more original matrix useful information (REAL:$M^1$) in 10 minute delayed recall instances than for an immediate recall.

The t-test comparison of information flow between the item recall of silent practice enumerators and immediate recall by individuals of group practice enumeration showed significatn differences for nine and thirteen year old subjects. In every instance the silent enumerator subjects processed greater rates of encoding and useful information of the original matrix condition than was processed by group practice subjects doing an immediate recall task.

An analysis of intra-age levels of information processing showed there were few differences, which were significant, for comparable modes of task processing. It was found that 13 year old subjects encoded (CODE) greater amounts of information than done by five year old children when considering the processing of item recall by subjects who had individually and vocally done the practice learning task.

The H(Y)$M^1$ information measure was used to determine whether or not there was any difference between 5 and 13 year old subjects in respective recall and practice tasks. It was found that (Table 12), individual activity of 13 year

TABLE 4

Amount of CODE Information for Vocal Practice and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 3.7483[a] | .6501 | 4.3039 | .3995 | 4.5020 | .6505 |
| Recall | 2.6180 | .8885 | 3.7510 | .4085 | 4.0157 | .4061 |
| 2) Group Practice: | | | | | | |
| Practice | 3.5408 | .4027 | 4.0140 | .4369 | 4.2044 | .3150 |
| Recall: Immediate | 2.6711 | 1.1410 | 3.5270 | .4309 | 3.7493 | .5680 |
| 5 Minute Delay | 2.9639 | .8736 | 3.6717 | .5572 | 3.8374 | .3526 |
| 10 Minute Delay | 3.0988 | .8208 | 3.4504 | .5017 | 3.7820 | .4434 |
| 3) Individual Silent: | | | | | | |
| Recall | 2.4229 | 1.1048 | 3.5502 | .6396 | 3.8395 | .3585 |

[a] To be read in bit value.

TABLE 5

Rate of Information Encoded for Vocal Practice and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 86.74 | 6.79 | 82.58 | 6.33 | 84.04 | 5.93 |
| Recall | 82.01 | 14.86 | 79.99 | 5.29 | 83.23 | 5.88 |
| 2) Group Practice: | | | | | | |
| Practice | 76.03 | 4.42 | 77.62 | 5.15 | 77.73 | 3.05 |
| Recall: Immediate | 78.67 | 24.75 | 79.77 | 7.81 | 78.92 | 6.05 |
| 5 Minute Delay | 84.82 | 15.04 | 79.73 | 7.10 | 80.29 | 6.22 |
| 10 Minute Delay | 91.43 | 9.18 | 78.46 | 6.22 | 79.40 | 5.47 |
| 3) Individual Silent: | | | | | | |
| Recall | 76.21 | 30.33 | 85.30 | 9.07 | 83.21 | 5.87 |

TABLE 6

Amount of REAL:M[1] Information Shared Between Messages for Vocal and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 3.8762[a] | .5877 | 4.3770 | .3985 | 4.5584 | .6438 |
| Recall | 2.6923 | .9053 | 3.8707 | .4063 | 4.0884 | .3890 |
| 2) Group Practice: | | | | | | |
| Practice | 3.6661 | .4007 | 4.1595 | .3985 | 4.3639 | .8140 |
| Recall:Immediate | 2.7185 | .9528 | 3.6035 | .3895 | 3.8312 | .5664 |
| 5 Minute Delay | 3.0143 | .8224 | 3.7835 | .5106 | 3.9309 | .3421 |
| 10 Minute Delay | 3.1208 | .8138 | 3.5727 | .5192 | 3.8786 | .4270 |
| 3) Individual Silent: | | | | | | |
| Recall | 2.4568 | 1.0523 | 3.6050 | .6107 | 3.8907 | .3271 |

[a] To be read in bit value.

TABLE 7

Rate of REAL:M[1] Information Shared Between Messages for Vocal and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 80.21 | 11.47 | 71.99 | 9.02 | 73.79 | 8.50 |
| Recall | 73.84 | 19.61 | 69.05 | 6.86 | 72.96 | 8.33 |
| 2) Group Practice: | | | | | | |
| Practice | 63.74 | 6.09 | 65.99 | 6.00 | 66.08 | 4.09 |
| Recall: Immediate | 72.73 | 19.59 | 68.40 | 9.84 | 66.87 | 7.97 |
| 5 Minute Delay | 77.65 | 17.70 | 68.86 | 8.28 | 69.10 | 8.58 |
| 10 Minute Delay | 85.87 | 13.75 | 67.17 | 8.19 | 67.81 | 7.06 |
| 3) Individual Silent: | | | | | | |
| Recall | 68.20 | 25.61 | 76.47 | 92.83 | 72.61 | 8.29 |

TABLE 8

Amount of LTM:M[1] Information for Vocal Practice and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 0.1279[a] | 0.2350 | 0.0730 | 0.0536 | 0.0564 | 0.0489 |
| Recall | 0.0743 | 0.1222 | 0.1197 | 0.0981 | 0.0727 | 0.0641 |
| 2) Group Practice: | | | | | | |
| Practice | 0.1253 | 0.0919 | 0.1455 | 0.1086 | 0.1593 | 0.0805 |
| Recall: Immediate | 0.0475 | 0.1122 | 0.0765 | 0.0604 | 0.0820 | 0.0508 |
| 5 Minute Delay | 0.0504 | 0.0912 | 0.1118 | 0.1143 | 0.0935 | 0.0861 |
| 10 Minute Delay | 0.0270 | 0.0452 | 0.1223 | 0.1070 | 0.0967 | 0.0087 |
| 3) Individual Silent: | | | | | | |
| Recall | 0.0339 | 0.0644 | 0.0548 | 0.0616 | 0.0512 | 0.0685 |

[a] To be used in bit value.

TABLE 9

Rate of LTM:$M^1$ Information Processed per Bit of REAL:$M^1$ Information for Messages of Vocal Practice and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 3.44 | 6.97 | 1.67 | 1.18 | 1.26 | 1.53 |
| Recall | 2.97 | 4.52 | 3.10 | 2.58 | 1.81 | 1.51 |
| 2) Group Practice: | | | | | | |
| Practice | 3.43 | 2.46 | 3.60 | 2.73 | 3.66 | 2.06 |
| Recall: Immediate | 7.29 | 23.73 | 2.27 | 2.01 | 2.16 | 1.36 |
| 5 Minute Delay | 3.26 | 8.71 | 3.17 | 3.94 | 2.39 | 2.14 |
| 10 Minute Delay | 0.78 | 1.81 | 3.37 | 2.85 | 2.53 | 2.39 |
| 3) Individual Silent: | | | | | | |
| Recall | 1.44 | 3.12 | 1.77 | 2.44 | 1.38 | 1.98 |

TABLE 10

Amount of Steady State Useful Information Shared Between Messages for Vocal Practice and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 0.4654[a] | 0.5043 | 0.5324 | 0.1826 | 0.5314 | 0.2188 |
| Recall | 0.3297 | 0.3127 | 0.5452 | 0.2725 | 0.5313 | 0.2390 |
| 2) Group Practice: | | | | | | |
| Practice | 0.6142 | 0.1650 | 0.6804 | 0.2144 | 0.6867 | 0.1414 |
| Recall: Immediate | 0.2693 | 0.2239 | 0.4850 | 0.2561 | 0.6140 | 0.2188 |
| 5 Minute Delay | 0.2199 | 0.2026 | 0.5348 | 0.2702 | 0.5997 | 0.2892 |
| 10 Minute Delay | 0.1820 | 0.2385 | 0.5673 | 0.2281 | 0.6245 | 0.2246 |
| 3) Individual Silent: | | | | | | |
| Recall | 0.2519 | 0.1640 | 0.3631 | 0.2191 | 0.4650 | 0.2464 |

[a] To be read in bit value.

TABLE 11

Rate of Steady State Useful Information Processed per Bit of
Useful Information for Vocal Practice and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 5.96 | 9.10 | 5.11 | 1.77 | 5.03 | 2.09 |
| Recall | 5.26 | 5.13 | 6.03 | 2.97 | 5.48 | 2.41 |
| 2) Group Practice: | | | | | | |
| Practice | 6.68 | 2.06 | 6.64 | 2.50 | 6.38 | 1.53 |
| Recall: Immediate | 8.19 | 17.24 | 5.46 | 2.88 | 6.59 | 2.48 |
| 5 Minute Delay | 3.49 | 3.35 | 5.98 | 3.47 | 6.20 | 2.66 |
| 10 Minute Delay | 2.51 | 3.51 | 6.37 | 2.36 | 6.57 | 2.49 |
| 3) Individual Silent: | | | | | | |
| Recall | 5.02 | 4.98 | 4.55 | 3.53 | 5.01 | 2.69 |

TABLE 12

Amount of Independent Output ( H(Y)) Information of the Original Matrix Condition for Vocal Practice and Recall of Picture Items

| | 5 years old | | 9 years old | | 13 years old | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| 1) Individual Vocal: | | | | | | |
| Practice | 4.4629[a] | 0.7178 | 5.2841 | 0.3174 | 5.3930 | 0.5614 |
| Recall | 3.2352 | 0.8965 | 4.8084 | 0.4321 | 4.8991 | 0.3636 |
| 2) Group Practice: | | | | | | |
| Practice | 4.7744 | 0.3458 | 5.3094 | 0.3760 | 5.5640 | 0.2729 |
| Recall: Immediate | 3.2142 | 0.8645 | 4.4993 | 0.3702 | 4.8107 | 0.4659 |
| 5 Minute Delay | 3.4834 | 0.7664 | 4.7050 | 0.4961 | 4.8920 | 0.5023 |
| 10 Minute Delay | 3.4360 | 0.9114 | 4.5144 | 0.5289 | 4.8557 | 0.4017 |
| 3) Individual Silent: | | | | | | |
| Recall | 2.9870 | 0.8985 | 4.2070 | 0.5872 | 4.6737 | 0.3849 |

[a] To be read in bit value.

old subjects who silently or vocally enumerated items, processed significantly greater amounts of $H(Y)M^1$ information than done by 5 year old children.

The dependence relationships between informatin measures for recall tasks and the variety of items recalled in the tasks were tested by regression analysis. The significant analyses are listed in Figure 3 of the Appendix. It should be kept in mind that the variety variable represents the number of different picture items verbally recalled by the subjects. The information flow, according to C. Shannon(7) is the amount of information "carried" per output message in the verbal recall. Consequently, the information "carried" per message was tested for linear dependence with the number of different items the subject could cognitively retrieve in the recall task.

The three age groups, of practice treatment, had three measures linearly related to recall variety. With only the exception of five minute delayed recall by individuals of group practice aged nine years, the CODE, REAL:$M^1$ and $H(Y)M^1$ measures were related to recall variety. The only other case of all three age groups processing information related to the recall variety was the steady state useful information (REAL:SS) for output by individuals of the vocal practice treatment.

The linear dependence of information flow for verbally recalling picture items and for a nonverbal, visual spatial location of items is shown in Figure 4 of the Appendix. This was a quite important aspect of the study, because it afforded an analysis of how the verbal cognition information flow per recall message was related to the visual memory output for the location of items originally seen in a picture display. The major information measures were the processors CODE and REAL:$M^1$, and $H(Y)M^1$; they accounted for three-fourths of the significant correlations. An interesting finding was that there was a recall information measure for every treatment group which had been involved in an immediate recall task. Only the five and nine year old groups had information flow of a 10 minute delayed recall output significantly related to space location performance. There were no information measures of five minute delayed recall which were significantly related to space location scores.

As a result of the previously described analyses, the information processed in practice enumeration and recall tasks was considered related to the number of different picture items (variety) recalled immediately or on a delayed basis. The same research position was drawn for the nonverbal or visual recall of the spatial location of items. The research group at the University of Pittsburgh has noted, from analyses, there is a good possibility that an information measure is the actual quantity carried for a cognition. The measures are those called useful information and identified as LTM:$M^1$ and REAL:SS. These were sed with processor information measures to construct a theoretical model of how information is retrieved and processed for a cognition. This algorithm was developed by G. Moser (see Empfield, 9) as a possible cognition information model. The algorithm equations were based on the useful information for the variety of items processed in a task. The information processor measures were identified as % CODE and % REAL:M[1]. Equation constructs of the algorithm were tested for obtaining predictions of average variety recalled by each age level and treatment. The number of equations per algorithmic prediction was tested as shown in Figure 5 of the Appendix. The average error for obtained recall variety for the 12 treatment groups was less than two percent. Only two of the prediction algorithms had three equations in a set. As the algorithm involved information measures of both the practice and recall tasks, each limited to a separate equation, the minimum number of two equations per set was then maintained in ten-twelfths of the tests.

The second aspect of the message processor algorithm approach was to predict the space location scores of groups of subjects. The same model was used as done for predicting recall variety. The major difference was the silent practice groups of the three age levels were included in tests to predict space location. The elements used for equation sets are shown in Figure 6 of the Appendix. The algorithms predicted the space location scores for an average of less than one-half percent difference. Six of the 16 equation sets used four equations and another three used three equations in a set of algorithm.

A second forecast model, developed by Moser (10) was used to test the role of practice and recall information measures in predicting space location scores of age groups of subjects. One of the four modality treatments was selected, by the hat method, for this analysis. The individual practice treatment was the one selected. The dimension forecast model is based on premises that a basic unit of useful information is found in the human memory. This unit changes for age of mental maturation (10) and cognition experiences (10). The basic unit is a value of 0.1548 bit and increments for change is of a value of 0.0129 bit of information.

The dimension algorithm is used with a % CODE for information flow of a subject in an observed task. In this study that measure was of the recall task processed prior to the spatial item location task; done by each subject. The equation was:

a) $\text{M unit} \pm .0129/\%\ \text{CODE} = \text{A}$

b) (A) (Recall Variety) = Spatial Location Score

The results of the algorithmic treatment for the three age groups are shown in Table 13. It was found that a less than one-half percent error occurred between the obtained and actual spatial location scores for the three age groups of subjects who had individually enumerated items in the practice learning experiment.

A major finding was that the M value processed by five year old subjects was significantly different (t-test analysis) from those processed by either the 9 or 13 year old subjects. The latter two groups were not found to differ in the level of M values used for predicting spatial location scores. The large variance, however, for the M value of the five year old subject group indicated greater differences occurred in levels needed for forecasts.

TABLE 13

Dimension Algorithm Characteristics for Forecasting Spatial Location Scores of Individual Vocal Practice Groups of Subjects, by Age Level

| Age Level | M-Unit | | M | | Obtained Score | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| 5 years | .6423 | .4941 | 37.71 | 38.23 | 6.85 | 2.45 |
| 9 years | .2687 | .0879 | 8.81 | 6.80 | 10.32 | 2.51 |
| 13 years | .3081 | .0767 | 11.86 | 5.94 | 12.53 | 2.79 |

The M-unit of the dimension algorithm was selected to analyze the dimension forecast relationship with the information measures and characteristics of practice and recall tasks. The results of these linear analyses are shown in Table 14.

An interesting but complex pattern of linear relationships of information measures, tasks characteristics and M-units was found from the analysis treatment. The major focus was on the relationships of useful information measures with the M-unit. The five year old group of subjects did not have significant linear dependences between the practice and recall tasks with respect to the LTM:$M^1$ and REAL:SS measures. However, the M-unit for forecasting the spatial location score was positively related with respect to the M-unit and the LTM:$M^1$ useful information of the practice enumeration task. On the other hand, the 9 and 13 year old groups of subjects processed LTM:$M^1$ and REAL:SS information levels of the practice and recall tasks which were positively related to each other. The REAL:SS measure of both age groups, and for both practice and recall task processings, were negatively related to the M-unit for forecasting spatial locations. In addition, the LTM:$M^1$ for recall by the nine year old subjects was related to the M-unit for the same regression direction.

The nine year old group of individual practice subjects had processing information measures of both recall and practice related to the M-unit. The % CODE and % REAL:$M^1$ of both recall and practice tasks were so related. On the other hand, the same measures of the 13 year old subjects were not significantly correlated, but were at about the 15% level of significance. The five year old group of subjects had processing information measures of the practice task, but not the recall task, significantly related to the M-unit of the space location forecast.

It should be kept in mind that the recall variety of the 9 and 13 year old subjects was found significantly related to the spatial location scores (see Figure 3, Appendix). As shown in Table 14 the practice (enumeration) variety of only the 13 year old subjects was significantly related to the spatial location score. Quite interestingly, a comparison of significant coefficients of correlation between recall information flow and spatial location score (as shown in Figure 4, Appendix) revealed that none of the measures listed in Table 14 were found to be so related. It can be seen in Table 14 that only the % CODE processed in practice tasks by five year old subjects was linearly related with the spatial location score.

The variety of terms output by subjects of any age in the practice enumeration task was positively related to the respective variety of the recall task. In other words, the more picture items verbally enumerated the greater was the variety of items recalled by the subjects. The same interpretation would be possible for the processing of a variety of verbal recall items and the number of picture items which could be spatially located in the visual mode task by 9 and 13 year old subjects. These findings indicate the task processing of learning and cognition by 9 and 13 year old subjects differed from that done by five year old subjects.

The 9 and 13 year old subjects processed useful information in a manner which was quite common. The pathway generally involved the steady state condition useful information. It can be seen in Table 14 that the REAL:SS measure flow in the practice task was positively related with the REAL:SS of the verbal recall level. Then the recall and practice REAL:SS measures were negatively related with the M unit. Remembering the equations of the dimension algorithm this relationship for the cognition of visually located picture items is quite logical.

The pathway of learning and cognition information processing by the five year old subjects was one which seemed to have greater linear relationship between practice learning flow and spatial location levels than for recall flow. The linear aspect between learning and cognition seems to be one of processors (% CODE and % REAL:$M^1$) with the useful information, or LTM:$M^1$ of practice tasks and the M-unit of the forecast of the spatial location score.

TABLE 14

Coefficients of Correlation Between Information Flow of Practice and Recall Tasks and Space Location Scores by Age Levels

| Practice Characteristics | | Recall Information: % CODE | % REAL | LTM:M[1] | REAL:SS | M-Unit | Recall Variety | Location |
|---|---|---|---|---|---|---|---|---|
| % CODE: | 5 years | .39[b] | | | | .14 | -.08 | -.41[b] |
| | 9 years | .71[a] | | | | .45[a] | -.20 | .02 |
| | 13 years | .50[a] | | | | .35 | -.44[a] | -.26 |
| % REAL:M[1]: | 5 years | | .52[a] | | | .45[a] | -.20 | -.32 |
| | 9 years | | .68[a] | | | .49[a] | -.24 | .02 |
| | 13 years | | .54[a] | | | .35 | -.40[b] | -.21 |
| LTM:M[1]: | 5 years | | | -.11 | | .38[b] | -.09 | .10 |
| | 9 years | | | .53[a] | | -.12 | .06 | -.01 |
| | 13 years | | | .43 | | -.27 | .38[b] | .25 |
| REAL:SS | 5 years | | | | -.12 | .30 | -.05 | .15 |
| | 9 years | | | | .65[a] | -.40[b] | .33 | .13 |
| | 13 years | | | | .77[a] | -.54[a] | .59[a] | .36 |
| VARIETY: | 5 years | | | | | -.57[a] | .59[a] | .15 |
| | 9 years | | | | | -.61[a] | .76[a] | .26 |
| | 13 years | | | | | -.20 | .42[b] | .53[a] |
| M-Unit: | 5 years | .14 | .22 | -.12 | -.26 | | | |
| | 9 years | .60[a] | .56[a] | -.44[a] | -.48[a] | | | |
| | 13 years | .34 | .34 | -.30 | -.53[a] | | | |

[a]Significant at the .05 level.
[b]Significant at the .10 level.

Conclusion and Discussion. This study was the first one to examine the information flow of visually perceived environment material and the cognition of that experience in both verbal and visual modalities. The experiments were controlled to measure learning differences for humans aged 5, 9 and 13 years.

The research question was to define differences in information processing. The Moser Memory Information Model was used to quantify the quality of both recall and learning tasks.

Information theoretic measures, such as NOISE:X, confirmed the belief that the experiment would evoke a recognition, low recall level kinds of cognition. The younger subjects showed greater ranges of task perception, particularly for learning by individuals, 10 minute delayed recall and recall by subjects of a non-verbal learning modality. These results indicate that the human perception of a task may be age related, but for differences for children of an age comparable to an early concrete level. Thereafter, a recognitory visual task is processed at a consistent level of channel control for both recall and learning tasks.

The variety of different number of picture items recalled by the children was found to differ for ages of children, but not for the way by which they did the learning task. That is, it did not matter whether the children silently or vocally enumerated the picture items, or viewed the picture in vocal groups of three children. The same conclusion was made for the nonverbal, visual location of items on an outline of the living room picture.

The findings of age but not modalities effects of learning and cognition have major importance for science educators. The age difference for learning and cognition efficiency is seen in the ratio of the variety of items recalled, as compared to those enumerated. The five year old children recalled 35 to 45 percent of the variety enumerated in the learning task. The ratio for nine year old children was 56-72 percent and it was 63-69 percent for 13 year old children.

The visual, nonverbal recall of picture items after a recognition task of the items to be spatially located was found to have a numerical pattern for ages of children. The five year old children could recall the spatial location of approximately six of the room items. The 13 year old children could place about nine items. The series of three items for age change was the pattern of memory retrieval.

The information measures of the recall tasks were selected to exemplify processing (% CODE and REAL:SS). Significantly different amounts of these resources were used depending both on the age of children and the modality they used in the learning task.

The linear analysis technique was used to establish a linear operator definition of information flow for the cognition tasks. It was found that the recall variety was related to information processing (CODE and REAL:$M^1$) for the original matrix condition, or short term memory, irrespective of age of subjects. The only non-linear operator occurred for nine year old children doing a five minute delayed recall. Another measure, H(Y)$M^1$, was used for control analysis and it corresponded to these findings but had significant relationships also for the nine year old group doing a five minute delayed recall of variety.

The linear relationship of useful information and the recall variety was less extensive than that found for processing measures. The linear operators were found to be more often the steady state useful information. Short term memory useful information (LTM:$M^1$), when found to be linearly related, occurred only for five year old children.

The linear relationships found for information flow influenced the testing of forecast algorithms. Two algorithms were used for the analysis. The first algorithm adhered to the C. Shannon[7] interpretation of information "carried" per message. The criterion control of the number of equations per set for forecasting the variety of recall and spatial location score was found to approach the minimum number of seven-eighths of the prediction of verbal recall task levels of variety and half of those for predicting spatial location scores. It was found that for averages, the algorithm for messages had an error level of less than two percent. In the case of variety for recall tasks the criterion of minimum equation set was violated by the five year old children treatments.

The second algorithm involved the recall variety rather than the message concept. This M dimension algorithm assumed information retrieval was by means of encoding rates (% CODE) and a basic unit of information structure at a 0.1548 bit value. An increment of 0.0129 bit was used as the algorithm dealt with cognition processes. The "hat method" was used to select a treatment group for testing the M-Algorithm of forecasts of spatial location scores. The group selected for the test was for those children who had individually done the vocal task of picture enumeration.

The five year old group of children was found to significantly differ with the 9 and 13 year children in the M increment needed to obtain a 99 percent confidence in forecasting spatial location scores. Linear analyses of M unit levels and information processed in the learning and recall tasks revealed the previously described pattern of differences between five year old children and the groups of children aged 9 or 13 years. The linear operator pathway for information flow was of short term memory information (LTM:$M^1$) by five year old children and the long term memory useful information (REAL:SS) for the 9 and 13 year old children.

These conclusions led to the drawing of a model for the way in which humans process visual information in a learning task and verbal and visual cognitions. Children chronologically in the pre-operational stage process less than two-thirds as many different items in a learning task and recall a little more than a third as many different picture items than done by children of greater levels of mental maturity. This is done through short term memory linear operations of information processing. The older children incorporate processing linear operations with a direct control of short term and long term useful information in memory treatments for the flow in learning and cognition activities.

This study could have a major importance for future research in science learning. Humans process information in learning tasks which is related to cognitions of either verbal or nonverbal kinds. The differences in processing are more age related than due to the modality of learning. This means greater emphasis should be placed on pedagogy policy of learning for mental maturation differences than for the teaching approach.

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FIGURE 1

Significant Differences (t-test) of Recall Variety and Spatial Location of Picture Items, by Levels of Age

| Treatment | Recall Variety: 5 V 9 Yrs. | Recall Variety: 5 V 13 Yrs. | Recall Variety: 9 V 13 Yrs. | Spatial Location of Picture Items: 5 V 9 Yrs. | Spatial Location of Picture Items: 5 V 13 Yrs. | Spatial Location of Picture Items: 9 V 13 Yrs. |
|---|---|---|---|---|---|---|
| 1) Individual Vocal Practice: | [a*] 9 | [a] 13 | | [a] 9 | [a] 13 | [a] 13 |
| 2) Group Vocal Practice: | | | | | | |
| Immediate Recall | [a] 9 | [a] 13 | [a] 13 | [a] 9 | [a] 13 | [a] 13 |
| 5 Minute Delay Recall | [a] 9 | [a] 13 | | [a] 9 | [a] 13 | |
| 10 Minute Delay Recall | [a] 9 | [a] 13 | [a] 13 | [a] 9 | [a] 9 | [a] 13 |
| 3) Silent Practice: Recall | [a] 9 | [a] 13 | [a] 13 | [b] 9 | [a] 13 | [a] 13 |

*To be read that 5 and 9 year old groups differed significantly in the variety of recall items, and the greater variety was recalled by the 9 year old group of subjects.

[a] Significant at .05 level (for N, see Table 1).

[b] Significant at .10 level (for N, see Table 1).

FIGURE 2

Significant Differences (t-test) of Information Measure Values
for Treatment Groups of Practice and Recall Tasks

| Information Measure | Vocal Group and Individual Practice | Individual Silent and Group Immediate Recall | Group Immediate and Delayed Recall | Practice and Respective Treatment Recall 5 V 9 | 5 V 13 | 9 V 13 |
|---|---|---|---|---|---|---|
| CODE | 9, 13[a] | | 5 yr. immed., 10 min. delay | | 13 | |
| % CODE | 5, 9, 13 | 9, 13 | | | | |
| REAL:M[1] | | | 5 yr. immed., 10 min. delay | | | |
| % REAL:M[1] | 5, 13 | 9, 13 | | | | |
| LTM:M[1] | 5, 13 | | | | | |
| % LTM:M[1] | 5, 13 | | | | | |
| NOISE: X:M[1] | 5, 9, 13 | 9, 13 | 5 yr. immed., 10 min. delay | | | |
| REAL:SS | 5, 13 | | | | | |
| % REAL:SS | 5, 13 | | | | | |

[a] To be read that 9 and 13 year old groups had significantly different levels of CODE processed for practice by the age level group and individual treatments.

FIGURE 3

Significant Coefficients of Correlation Between Information Measures of Recall Tasks and the Variety of Items Recalled, by Age Level

| | Individual Practice | | Group Practice | | |
|---|---|---|---|---|---|
| | | | | Delayed | |
| Information Measure | Silent | Vocal | Immed. | 5 minute | 10 minute |
| CODE | 5,9,13 | 5,9,13 | 5,9,13 | 5, 13 | 5,9,13 |
| % CODE | 5, 13 | | 5, 13 | 13 | |
| REAL:$M^1$ | 5,9,13 | 5,9,13 | 5,9,13 | 5,9,13 | 5,9,13 |
| % REAL:$M^1$ | 5, 13 | | 13 | 13 | |
| LTM:$M^1$ | | | 5 | 5 | |
| % LTM:$M^1$ | | | | 5 | |
| NOISE: X:$M^1$ | 5, 13 | | | 13 | |
| REAL:SS | 13 | 5,9,13 | 9 | 13 | 9 |
| % REAL:SS | | | 5 | | 9 |
| H (Y) $M^1$ | 5,9,13 | 5,9,13 | 5,9,13 | 5,9,13 | 5,9,13 |
| . . . . . . | | | | | |
| Space Location Items | 5 | 9,13 | 9 | | 9 |

[a] To be read that recall CODE was significantly correlated (.05 level) with the recall variety of silent practice treatment groups aged 5, 9, and 13 years.

FIGURE 4

Significant Coefficients of Correlation Between Information Measures of Recall Tasks and the Number of Picture Items Spatially Located in a Room Cut-out

| | Individual Practice | | Group Practice | | |
|---|---|---|---|---|---|
| | | | | Delayed | |
| Information Measure | Silent | Vocal | Immed. | 5 minute | 10 minute |
| CODE | 5[a] | 9, 13 | 5,9,13 | | |
| % CODE | | | | | |
| REAL:$M^1$ | 5 | 9, 13 | 5,9,13 | | 9 |
| % REAL:$M^1$ | | | | | |
| LTM:$M^1$ | | | | | 5, 9 |
| % LTM:$M^1$ | | | 13 | | 5, 9 |
| NOISE: X:$M^1$ | | | | | |
| REAL:SS | | | | | 9 |
| % REAL:SS | | 5 | | | 9 |
| H (Y) $M^1$ | 5,9,13 | 9, 13 | 5, 9 | | 9 |

[a]To be read that the recall CODE was significantly correlated (.05 level) with the items spatially located by the individual silent practice treatment group of subjects aged 5 years.

FIGURE 5

Task Elements for Predicting Recall Variety, Processing Algorithm

| | Practice Elements | | | | | | | Recall Elements | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment Group | A | B | C | D | E | F | G | A | B | C | D | E | F | G | Obtained Variety |
| 1) Individual Vocal: | | | | | | | | | | | | | | | |
| 5 years | | | 1* | 1 | | 1 | 1 | | | 2 | 2 | 2 | 2 | 2 | 11.74 |
| 9 years | | | 1 | 1 | | 1 | 1 | 2 | | | | | | 2 | 32.59 |
| 13 years | | | 1 | 1 | | 1 | 1 | 2 | | | | | | 2 | 35.51 |
| 2) Group Practice, Recall: | | | | | | | | | | | | | | | |
| a) Immediate | | | | | | | | | | | | | | | |
| 5 years | | | 1 | 1 | | 1 | 1 | | | | | 2 | 2 | 2 | 11.18 |
| 9 years | | | 1 | 1 | | 1 | 1 | | | | 2 | 2 | 2 | 2 | 26.39 |
| 13 years | | | 1 | | | 1 | 1 | | | | 2 | 2 | | 2 | 33.92 |
| b) 5 Minute Delay: | | | | | | | | | | | | | | | |
| 5 years | | 1 | 2 | | | | 1 | | 3 | | | | | 3 | 12.97 |
| 9 years | | | 1 | 1 | | 1 | 1 | | | | 2 | 2 | 2 | 2 | 30.94 |
| 13 years | | | 1 | | | 1 | 1 | | | | | 2 | 2 | 2 | 36.22 |
| c) 10 Minute Delay: | | | | | | | | | | | | | | | |
| 5 years | 1 | | | | | 2 | 1 | | 3 | | | | | 3 | 13.18 |
| 9 years | | | 1 | 1 | | 1 | 1 | | | | | 2 | | 2 | 26.90 |
| 13 years | | | 1 | | | 1 | 1 | | | | 2 | 2 | | 2 | 34.84 |

Legend:

A is % CODE

B % REAL:$M^1$

C LTM:$M^1$

D % LTM:$M^1$

E REAL:SS

F % REAL:SS

G Variety

*To be read that Practice LTM:$M^1$ was used in Equation No. 1 of algorithm.

FIGURE 6

Task Elements for Predicting Space Location of Picture Items, Processing Algorithm

| Treatment Group | Practice Elements | | | | | | | Recall Elements | | | | | | | Obtained Space Location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | A | B | C | D | E | F | G | |
| 1) Individual Vocal: | | | | | | | | | | | | | | | |
| 5 years | | 1 | | | | | 1 | | 2 | 3 | 3 | 3 | | | 6.83 |
| 9 years | | | | | 1 | | 1 | | 2 | | | 3 | 3 | | 10.50 |
| 13 years | | | | | 1 | | 1 | 2 | | | 3 | 3 | | | 12.43 |
| 2) Group Practice: | | | | | | | | | | | | | | | |
| a) Immediate: | | | | | | | | | | | | | | | |
| 5 years | | | | | 1 | | 1 | | | | 2 | 2 | | | 6.70 |
| 9 years | 1 | | | | 2 | | 1 | | 3 | 4 | | 4 | | | 9.47 |
| 13 years | 1 | | | | 2 | | 1 | | 3 | | | 4 | 4 | | 12.08 |
| b) 5 Minute Delay: | | | | | | | | | | | | | | | |
| 5 years | | | | | 1 | | 1 | | | 2 | | 2 | 2 | | 5.97 |
| 9 years | 1 | | | | 2 | | 1 | | 3 | | | 4 | 4 | | 10.15 |
| 13 years | 1 | | | | 2 | | 1 | | 3 | | | 4 | | | 12.08 |
| c) 10 Minute Delay: | | | | | | | | | | | | | | | |
| 5 years | | | 1 | 1 | 1 | | 1 | 2 | 3 | | | 3 | | | 6.86 |
| 9 years | 1 | | | | 2 | | 1 | | 3 | | | 4 | | | 9.39 |
| 13 years | 1 | | | | 2 | | 1 | | 3 | | | 4 | | | 12.34 |
| 3) Silent Practice: | | | | | | | | | | | | | | | |
| 5 years | | | | | | | | | 1 | | | | | 1 | 6.92 |
| 9 years | | | | | | | | 1 | | 2 | | 2 | 2 | 1 | 8.55 |
| 13 years | | | | | | | | 1 | | | | 2 | 2 | 1 | 12.92 |

Legend:

A is % CODE

B % REAL:M[1]

C LTM:M[1]

D % LTM:M[1]

E is REAL:SS

F % REAL:SS

G Variety